Wind, rain, temperature and construction contracts: how to provide for climate change in your engineering and construction project

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The construction industry is one of the most vulnerable industries to the effects of climate change due to its reliance on outdoor activities and labor. Forty-five percent of construction projects are affected by adverse weather, on a global level, resulting in billions of dollars in additional costs each year, mainly due to expensive schedule overruns.[1] A recent systematic study confirmed that the most impactful weather events on construction projects are extreme temperatures (and humidity), precipitation and high winds.[2] Each can lead to decreased productivity or render certain tasks on the critical path unfeasible, thereby affecting the project schedule, overall costs or the quality of the work performed (as well as affecting logistics and the supply chain).

It is increasingly important to consider how these events can and should be dealt with legally on major construction projects given two important factors. First, the demonstrated increase, due to climate change, in the frequency and unpredictability of extreme weather events, which will have negative knock-on effects on major construction projects and make historical weather data in project documents increasingly inaccurate (and thus exacerbate the parties' dispute).[3] The most recent global, authoritative climate report – the World Meteorological Organization's State of the Global Climate 2020 (published in April 2021) – confirmed that greenhouse gas emissions continued to rise in 2020, one of the three warmest years on record, despite the economic slowdown caused by the pandemic.[4] Hurricanes, extreme heatwaves, severe droughts and wildfires resulted in tens of billions of US dollars in economic losses (and many deaths). The second factor why this issue deserves attention is the fact that climate change is still a relative newcomer to the list of issues addressed at the planning stage of major projects[5] and is given relatively little attention despite its increasing impact.[6]

Current technological innovations are not enough to solve the difficulties faced. Modular integrated construction (MiC) and Building Information Modelling (BIM) can reduce the amount of onsite construction work that can be affected by local adverse weather conditions but they cannot fully address these difficulties. For example, MiC is ill suited to address necessary onsite adjustments to design and construction and effective 4D BIM requires a high level of IT skills and resources that are not available in many regions. In any event, it is prudent for parties to expressly address in as much detail as possible how adverse weather events are to be dealt with under their contract to avoid surprises later. Indeed, certain widely used model construction contracts explicitly deal with risk allocation for particularly adverse weather e.g., the 2017 FIDIC Red Book and NEC4 Engineering and Construction Contract, and these are considered in further detail below. This article therefore provides an overview of the types of difficulties and disputes that adverse weather conditions cause on major construction projects (1) before addressing how this risk is or can be dealt with in the parties' contract (2).

Most common adverse weather conditions and associated disputes

Temperature

Extreme temperature or temperature variation can cause serious problems on major construction projects.

Hot weather, heatwaves and sharp increases in humidity can cause productivity to fall and delays to be incurred. The construction industry relies on manpower whose productivity can be affected by excess heat, the presence of large amounts of dust on dried out work sites, and other heat-related difficulties.[7] One of the reasons many UAE construction companies employ workers from hot countries is their ability to cope with working in such hot conditions although they can still succumb to heat stress. Issues such as absenteeism and turnover, together with the time spent on complying with health and safety procedures introduced to address the effects of heat, can all lead to a drop in productivity and delays. Heat-related issues are typically accounted for in the planning for large construction projects in the UAE, but the same is not true for projects in relatively more temperate climes such as Europe.

Hot weather also negatively affects materials. It can accelerate the rate at which freshly mixed concrete dries out, causing thermal cracking and a reduction in the compressive strength and quality of finish of the concrete. Efforts to address the moisture loss through, for example, increased application of water, may unwittingly reduce the concrete's strength. This can give rise to a claim based on defective concrete, which will likely be preceded by a claim for delay due to the extra time needed for the concrete pouring.

By contrast, cold weather can lead to problems starting engines, while extreme cold weather can lead to certain materials becoming more brittle, although this is more of an issue in arctic conditions.

The latest WMO climate report shows that many parts of Brazil recorded their highest temperatures ever in 2020. Likewise, there were intense and widespread heatwaves in Peru and northern Argentina. This trend is set to continue across the world and can, does and will continue to cause disputes regarding time, quality and cost.

Wind

Strong winds can affect materials, labor and equipment through the use of restraints and protective measures in respect of work under construction e.g., inability to work on scaffolding during high winds or electric storms. Wind can also affect the pouring of concrete, which typically can take place only when wind speed is less than 55 km/h.[8] Activities using steel are frequently found on the critical path and wind speeds above 60 km/h normally require steel lifting operations, that use cranes, to be cancelled. In fact, many countries have regulations that significantly restrict crane operations in high winds.[9]

The recent WMO climate report stated that the North Atlantic experienced a record number (30) of tropical storms during its 2020 hurricane season. In the US, 12 such storms made landfall, breaking the previous record of nine. These caused extensive wind and storm surge damage, particularly in Louisiana, and similar storms wreaked havoc in Central America and came closer than ever to the Colombian national territory.

Precipitation

Heavy rainfall can destabilize soils and turn them into mud, making work difficult or temporarily impossible e.g., on motorway or foundation works. The use of tracked, as opposed to wheeled, vehicles to try to overcome the muddy conditions is typically slower and more costly.

Intense rain can also lead to flooding of construction sites, as we have seen recently in many construction sites in the Middle East.

The WMO climate report made clear that annual precipitation totals in monsoon-influenced regions in North America, Africa, South-West Asia and South-East Asia were unusually high in 2020, as were extreme daily totals.

Dealing with the risk of the effects of adverse weather

Weather-related events and their consequences are often poorly or inadequately set out in construction contracts. Standard form contracts can provide a general framework for addressing these events in terms of time and cost but these contracts typically a) leave important details to be agreed between the parties based on the specific facts of the project, and/or b) have a default position on time or cost entitlements that may not be appropriate for the particular project. Within the parties' margin for project planning and amending the standard form provisions, there is scope for minimizing the risk presented by weather-related events. Set out below is the manner in which adverse weather is addressed in the 2017 FIDIC Red Book and NEC4 contract, followed by some tips on minimizing risk at the planning and contract drafting phase.

2017 FIDIC Red Book

The 2017 FIDIC Red Book explicitly grants entitlement to a time extension for "exceptionally adverse climatic conditions" but does not grant a right to claim additional costs or to suspend the works for this reason. [10] Under the Red Book:

- The Employer must provide to the Contractor all data in its possession on the climatic conditions at the site but the Contractor is responsible for interpreting that data, and is deemed to have inspected the site and satisfied itself as to the climatic conditions and their effects at the site before submitting the tender.[11]
- The Contractor is entitled, on giving the appropriate notice, to an extension of time if completion is or will be delayed due to "exceptionally adverse climatic conditions, which for the purpose of these Conditions shall mean adverse climatic conditions at the Site which are Unforeseeable having regard to climatic data made available by the Employer under Sub-Clause 2.5 [Site Data and Items of Reference] and/or climatic data published in the Country for the geographical location of the Site". [12]
- The Contractor is also entitled to an extension of time in the event of a natural disaster such as a hurricane or typhoon.[13] The 2017 Red Book marks a change compared to the 1999 version in that the latter (Sub-Clause 17.4(b)) allowed the Contractor to claim both an EoT and costs for rectifying the loss and damage whereas only an EOT is explicitly provided for in the 2017 version. A Contractor may even have to incur acceleration costs as a result of the delay caused by the storm.
- The Contractor is therefore entitled to an extension of time unless the climatic conditions were identified by the Employer prior to contract execution or were otherwise foreseeable.

The answer as to whether or not a weather event was reasonably foreseeable by an experienced contractor before entering into the contract (and therefore, whether it was exceptional under Sub-Clause 8.5(c)) will depend on the region and time at which the event occurred. This is something that will evolve in tandem with the changes in local climate conditions which may mean that what was exceptional 15 years ago no longer is. Whether the weather event is "adverse" will depend on the evidence produced of the impact of the conditions on work progress and will be determined by the Engineer. Note that, if a weather-related delay is concurrent with a delay that is the Contractor's responsibility, the Contractor's EoT entitlement is assessed under the Special Provisions (or, if not stated, taking account of all relevant circumstances).[14]

NEC4 Engineering and Construction Contract

Under Clause 60.1(13), the contractor is entitled to compensation (through notification and later submission of

quotations to the project manager[15]) if a weather measurement is recorded:

- within a calendar month;
- before the completion date for the whole of the works;
- at the project site, and
- the value of which, by comparison with the weather data provided, is shown to occur on average less frequently than once in 10 years.

The weather measurement is limited in its scope to precipitation (rainfall and snow) and air temperature below a minimum level. The weather data consist of past weather measurements, to be included in the contract, and it is only the difference between them that is to be taken into account in assessing the compensation, which is often provided as changes to the prices via agreed rates or lump sums.[16] Changes to key dates and the completion date are also possible (Clause 63.6).

Clause 60.1(19) grants the same entitlements as Clause 60.1(13) but for events which stop the contractor from completing the works, or completing them by the scheduled date, where the (duly notified) event:

- could not be prevented by either party;
- would have been judged by an experienced contractor at the date of contract execution to "have such a small chance of occurring that it would have been unreasonable to have allowed for it"; and
- is not one of the other compensation events stated in the contract (and so it must be different from the weather event described above e.g., arguably hurricanes or intense heatwaves).

Clause 19.1, entitled "Prevention", has the same requirements as Clause 60.1(19) and provides that, upon the occurrence of such an event, the project manager must give an instruction to the contractor stating how the event is to be dealt with.

Tips on minimizing weather-related risk

Parties to major construction projects would be well advised to, **first**, adequately define adverse/abnormal weather. For example, the FIDIC guidance on Sub-Clause 8.5 (Extension of Time for Completion) states that "[i]t may be preferable to set out in the Specification what constitutes an "exceptionally adverse" event - for example, by reference to available weather statistics and return periods. It may also be appropriate to compare the adverse climatic conditions that have been encountered with the frequency with which events of similar adversity have previously occurred at or near the Site." One notes, however, that the recommended approach is a historical approach, which will be of increasingly limited value for tackling unpredictable, but more frequent, future adverse weather events in the context of climate change.

It is advisable to set out what weather events should be captured, what data used and how comparisons should be made. For example, is the exceptional nature of rainfall to be based on maximum daily values or maximum monthly values, and from which weather station? An employer may bring a claim against a contractor, alleging that the contractor allowed the worksite to flood, in breach of the earthworks specification, and basing its claim on the fact that no day in the relevant period exceeded the maximum daily rainfall levels in the data the employer provided. The contractor may, in turn, highlight the frequency of the rainfall (which may not have allowed the soil to dry and may have made it impermeable) and point to the total rainfall for the relevant month or season being far above the average based on precipitation data for the region. To help avoid disputes such as these, it may be preferable to clearly establish in the contract what specific rainfall and site data are to be used to assess foreseeability of flooding and, for

instance, the need for and timing of dewatering measures. Where the project is geographically expansive and may be subject to micro-climates, such as a highway project, it may be prudent to include various locations to measure the weather data, and to ensure that historic data for each of these locations is also included to enable a comparison to be made in an uncontroversial manner.

It is possible that, in preference to or together with historical data, reliance will increasingly be placed on reference to prediction tools such as advanced modelling, used at the planning stage and the results of which constitute the contractual reference point by which anomalies or particularly adverse conditions are measured. Weather modelling comprises three main types of models that seek to determine the impact of weather on workers, equipment and schedule: weather generation models, construction impact models and project scheduling models.

- Weather generation models use site-specific weather, historical weather or (if historical data is not available) geographic extrapolation data to simulate or predict delay-causing weather events in the construction area.
- Construction impact models rely on stochastic weather model results to ascertain impacts on certain construction factors, like worker productivity (although, problematically, no standard definition of worker productivity exists).[17]
- Project scheduling models use construction site conditions, weather impacts and worker productivity to create efficient schedules. Near-optimal schedules that minimize time and cost of construction can be generated from multi-objective optimization models and building information models, which run simulations to integrate construction information into productivity rates for a similar purpose.

The advantage of using these models as opposed to historical data clearly depends on the parties' comfort with the accuracy of the models and how their results are interpreted.

Secondly, parties should provide for the direct and indirect consequences of the adverse weather event. They should include abnormal weather events as excusable delay events entitling the relevant party to a time extension. Where no provision is made for additional costs in such situations (like in the 2017 FIDIC Red Book for events such as hurricanes), it may be appropriate to do so depending on the project and region. After all, local climatic conditions (such as precipitation rates or temperature levels) may, in the future, be modified for a number of years such that what was abnormal no longer will be. This could justify additional costs for the contractor who has to contend with such challenging conditions. It is also advisable to explain how additional time due to an excusable delay event such as exceptionally adverse weather is calculated e.g., including the effects of the adverse weather conditions on non-working days or not.

Thirdly and finally, depending on the project characteristics, the parties' contract should provide for robust health and safety policies such as work-rest cycles and the provision of weather-appropriate protective gear. The contractor should ensure that the expenses for dealing with adverse weather are, to the extent possible, priced into the contract. Going forward, these costs may well extend to disaster-proofing measures for infrastructure or measures to mitigate the effects of storms, such as cloud seeding.

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12. Sub-Clause 8.5(c). "Unforeseeable" is defined to mean "not reasonably foreseeable by an experienced contractor by the Base Date [*28 days before the latest date for submission of the Tender*]."↩
13. Sub-Clause 18.4.↩
14. Sub-Clause 8.5.↩
15. Clauses 61 and 62, NEC 4.↩
16. Clause 63.2 and Contract Data, Part 1.6.↩
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